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June 10, 1996

William F. Caton
Acting Secretary
Federal Communications Commission
Room 222
1919 M Street, NW
Washington, DC 20554

Dear Mr. Caton:

I am enclosing an original and eleven copies of comments by Sony Electronics Inc. in response to MM Docket No. 87-268, Fifth Further Notice of Proposed Rulemaking, Advanced Television Systems and Their Impact Upon the Existing Television Broadcasting Service.

Very truly yours,

Jason Farrow
(jmb)

JF:p
Encs.

ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service	)	MM Docket No. 87-268

FIFTH FURTHER NOTICE OF PROPOSED RULE MAKING

COMMENTS OF SONY ELECTRONICS INC.

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COMMENTS OF SONY ELECTRONICS INC.

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FEDERAL COMMUNICATIONS COMMISSION
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COMMENTS OF SONY ELECTRONICS INC.

Sony Electronics Inc. hereby files comments in response to the Commission's Fifth Further Notice of Proposed Rule Making in the above-captioned proceeding.

I. EXECUTIVE SUMMARY

SEL urgently supports the Commission's proposal to mandate the entire ATSC DTV standard (NPRM¶37). By taking this action, the Commission will complete the work begun by this proceeding in 1987 and enable the emergence of innovative and exciting digital advanced television services. We believe that the development of a U.S. DTV system encompassing digital HDTV and digital SDTV will bring significant economic, educational and technical benefits, most of which cannot be predicted, to all Americans. We firmly believe that only a mandate will accomplish this and the Commission's goals of preserving free, universal broadcast television service and facilitate the earliest practical return of the analog spectrum to the public.

The Grand Alliance HDTV system is the product of a process of unprecedented cooperation between government and industry with participation from television broadcasters and equipment manufacturers, cable TV, motion picture, and

telecommunication and computer interests. The Advisory Committee appointed by the Commission made a great effort to understand and accommodate the requirements of all. There were years of meetings and hundreds of volunteers dedicated to searching out the best solution for all those who participated -- including laboratory and field testing. The Commission itself sought comment and input through a series of notices. The process was fair, open and deliberate and the resulting standard is "a remarkably capable and flexible system, one that exceeds the Commission's expectation. . ." (NPRM¶37). Now is the time for action. As we explain more fully below, the standard should be mandated by the Commission as only a mandated standard will enable a timely transition from NTSC to ATV.

All elements of the proposed standard should be included in the mandate as they represent proven technology and were designed for flexibility to accommodate the needs of all parties. Only the inclusion of interlace as well as progressive scanning will enable the immediate broadcast of both motion picture film and live events television. Some in the motion picture industry have criticized the ATSC standard. However, it allows 1920 x 1080 full HDTV resolution motion picture film at 24/30 frames per second progressive scan to be transmitted today, thus fully satisfying their concerns. Live HDTV origination, however, at full resolution at 60 pictures per second cannot be transmitted through 6 MHz bandwidth except as 60 Hz interlace. The genius of the standard is that it allows both from the moment the new DTV system comes on line. Therefore U.S. television viewers will be able to enjoy all the types of programs they now have -- including movies, and live news and sports -- immediately. The 60 Hz transmission rate

also ensures full resolution HDTV transmission through the narrow 6 MHz channel. The 16:9 aspect ratio is necessary to allow the transmission of original 4:3 aspect ratio film and television programming, vintage motion picture wide screen formats, and the current use of a number of different wide screen motion picture formats and still keep the price of a television set (display tube) within the reach of today's television consumer. The colorimetry standard is pragmatic and internationally accepted. The television and computer industries agreed on the use of square pixels for all HDTV formats. This will benefit both by encouraging convergence. However, the use of non-square pixels are necessarily retained in SDTV as there is already a global 525- and 625-line digital reality that cannot be ignored. These and other features of the standard were selected to promote maximum interoperability

The products of this standard -- HDTV transmissions -- have been seen and overwhelmingly admired by both industry insiders and today's television consumers. The further development of this technology will bring even more exciting viewing experiences to U.S. and global consumers. In contrast, the standard's critics have nothing positive to offer. Their criticisms of core technical parameters that underlie the ATSC DTV standard are largely vague and theoretical. They stubbornly ignore both the inter-industry consensus and the grueling lab and field tests that so solidly support this standard. Nor have these critics offered any alternative solutions that meet the severe transmission constraints for which that standard was so carefully forged. Their position would deny the benefits without offering a better practical alternative. SEL totally

supports the Commission's wisdom of insisting that the burden of proof fully rests on the critics.

SEL enthusiastically supports and endorses the comments of the Advanced Television Systems Committee in this proceeding. We have chosen to focus our own response on our support of the crucial elements of the proposed standard and to set out as clearly as possible the technical bases for this support from the point of view of a major manufacturer of consumer electronics, digital telecommunications, computers and computer peripherals.

II. INTRODUCTION

Sony Electronics Inc. (SEL) is the electronics research, design, manufacturing and distribution subsidiary of Sony Corporation of America. We believe SEL is uniquely positioned to offer its comments in this proceeding because of its long history in the United States, its close ties as a supplier to the broadcast and computer industries, its cutting edge research and development of digital products, and its reputation as a producer of high-quality television products for the consumer. Sony was the first Japanese television manufacturer to establish production in the United States in 1972 in San Diego and began research and development in the United States in 1977. Currently, SEL employs over 10,000 Americans in 25 states including nine production plants, research and development facilities in four locations, and two major technology centers in San Diego, CA and Pittsburgh, PA.

In 1995, SEL manufactured over 850,000 television sets at its San Diego Manufacturing Center with an average domestic content of 80% and 2,950,000 color

television and computer display cathode ray tubes (CRTs) with an average domestic content of 92%. SEL recently announced a $9 million expansion of the San Diego facility to include the construction of a new and enlarged Center for Engineering and Development. SEL manufactured over 122,000 projection television sets with an approximate domestic content of 80% at its Pittsburgh Manufacturing Center, which is also the site of a $300 million television glass manufacturing operation formed June 1995 which will ultimately employ approximately 500 people when it comes on-line. Its products will be used for the front panels and rear funnels of picture tubes produced in North America. The company is also a major supplier of equipment for broadcast stations and is the only company currently manufacturing color computer CRTs in the United States.

SEL, through its joint venture with Qualcomm Inc., has also become a major supplier of cellular communication devices, including digital telephones.

SEL's $8.5 billion sales in the United States last year included $1.3 billion in computer peripherals. An ever-increasing portion of SEL's United States sales volume is attributable to its computer, computer peripheral, and telecommunication products. The projected sales from these sectors is expected to reach $4 billion in the very near future.

As a major manufacturer of professional broadcast equipment, Sony has been heavily involved in the development of all core equipment related to HDTV production. We have brought no less than three successive generations of HDTV cameras and recorders to the international marketplace. We have pioneered digital NTSC, SDTV and HDTV production developments on an unprecedented scale -- and, in doing so, we have

worked closely with many prestigious program producers and broadcast organizations all over the world. This experience has provided us with real, practical knowledge of the problems and priorities that will face the broadcast industry over the first decade of HDTV service.

Sony Corporation of America, SEL's parent, through Sony Pictures Entertainment in Culver City, CA, , operates the nation's largest facility dedicated to adapting HDTV technology to meet the needs of the motion picture industry.

In November 1995, Sony Corporation and Intel Corporation announced the establishment of a long-term cooperative business relationship to jointly develop hardware and software architectures and key devices for the information technology market. One of the first products from this collaboration, Sony's VAIO PC, was recently introduced to the public at PC Expo in New York SEL has a long history of supplying the U.S. and global computer industry with peripheral devices including monitors and optical and magnetic storage products. SEL's semiconductor company conducts research and manufacturing in the United States at San Jose, California, and San Antonio, Texas. SEL's United States manufacturing equals 40% of its total United States sales and more than $1 billion of SEL's United States manufactured goods are exported to other countries.

In addition to its solid roots in the United States, Sony has been an active member of the various SMPTE working groups and ATSC technology groups that produced the digital High Definition electronic production standards Sony has also been an active participant in the process that led to the development and recommendation of the ATSC

DTV transmission standard. Sony Advanced Systems Company and Sony Pictures Entertainment are members of the ATSC. SEL enthusiastically endorses the Committee's comments filed in this proceeding. Along with other members, SEL has invested significant time and resources over the long years dedicated to this process and looks forward to the benefits that will ensue to its customers in the broadcast and computer industries, in consumer television, and to its United States employees when adoption of a standard will make practical the transmission and reception of ATV.

Therefore, SEL emphatically supports the Commission's proposal (NPRM¶37) to adopt the ATSC standard and urges it to mandate all elements of the standard for the following reasons.

III. THE COMMISSION SHOULD MANDATE THE ATSC STANDARD. ONLY A MANDATED STANDARD WILL ENABLE THE TIMELY TRANSITION FROM NTSC TO ATV.

Throughout the process that led to the adoption of the ATSC standard, the unambigous common understanding was that such a standard would be mandated for use by terrestrial broadcasters as was the NTSC standard. As the Commission notes, the NTSC mandate was necessary to develop a national broadcasting system in television's infancy (NPRM¶22). In a very real sense, we are in the infancy of yet another industry -- that of digital television, and the same rationale that supported a mandatory standard then supports a mandate now.

The original mandated analog NTSC standard is a testament to the security provided alike to broadcasters, manufacturers, program producers, and consumers. That

security was considered important in an era that had to deal with only one medium of over the air terrestrial live television (the role of prerecorded programming was little understood back in the 1940s). Today, any service provider must contend with a plethora of competing media (transmission "pipelines" of satellite, cable, wireless cable, terrestrial, telco -- and also new digital "packaged" media such as DVD, CD-ROM, DVC, etc.). Within such a versatile marketplace environment competitive business uncertainties abound.

Only a mandate can provide the requisite degree of certainty and security for all interested parties that will insure the swift introduction of HDTV. It will set a direction and establish rules for different entities -- all crucially dependent on each other -- content providers, broadcasters, manufacturers, consumers, investors, and others. Broadcasters must be assured that cost effective receivers will exist to transform their signals into programming for consumers. By the same token, manufacturers must know that, after they expend resources on research, development and production, there will be enough attractive programs to induce consumers to purchase digital television products. Investors must be confident that their financial support is not at significant risk and that there will be a reasonable chance of return on their investments. Not least, "(C)onsumers need to know that a TV set bought in Richmond will also work in Rochester and in Redwood City."[1]

[1] Remarks of Commissioner Ness at the Wireless Communications Summit, June 10, 1996, "Spectrum Manaement Principles for the Twenty-First Century" explaining why she believes "free over-the-air broadcast services require a transmission standard if equipment is to be widely available at low prices" as an exception to her articulated principle of generally avoiding mandating standards.

Most participants support a mandate (NPRM¶25). Indeed, it was with this understanding that participants in the process expended their significant time and resources to participate in a process that was known at the time to be a quest for a mandated standard. It is disturbing to realize that their reliance on this understanding may have been a mistake, especially since there is no compelling reason to back away from a mandate. As discussed more fully below, the standard consists of proven technology with the flexibility to accommodate diverse uses. It holds the formula to allow the U.S. to enter the 21st century with broad scale harmonized digital television services. It was forged with the participation of the television, motion picture, film, computing and telecommunications industries. The ATSC DTV standard, like all standards, has its critics. The Commission properly and wisely has stated that the burden of persuasion as to why the standard should not be adopted lies squarely on those opposing it. SEL agrees with this view.

The ATSC DTV standard is, first and foremost, a television standard. We support all measures that accommodate a continuing technical convergence between television, computing and telecommunications -- but only to the extent such measures do not violate the clear imperatives of the television industry, which must balance the ongoing evolution of today's analog NTSC-based system with the newly emerging digital advanced television services.

Some criticism is inevitable -- as this inter-industry accommodation simply cannot immediately fulfill all of the desires of all three industries. However, the blanket

criticism of some -- that virtually all primary technical parameters of the ATSC DTV standard (namely, scanning formats, transmission rate. aspect ratio, colorimetry, pixel structure) have serious shortcomings -- suggests. at best, a profound lack of understanding of all that constitutes a television system. At worst, it suggests a cynical and parochial dismissal of the critical priorities of the television industry. These priorities involve the multi-faceted challenges of program creation and distribution to the consumer, via an unprecedentedly complex transmission channel. Stories, information, pictures and sound together constitute the very heart of television services. As such, they demand careful attention to a multiplicity of technical parameters within all segments of the highly complex television transmission process. As we detail below, the Grand Alliance System provides the technical methods of solving the problems of digital television transmission without sacrificing the needs of the computer and motion picture industries.

There is also a critical issue of United States leadership at stake. All developed regions of the world are currently preoccupied with the development of advanced television schemes. All have been following events in the United States. Many are closely studying our ATSC DTV standard in the light of their own developing ATV agendas. Some have already expressed interest in adopting our standard in its entirety. This would have significant benefits. In rallying a larger portion of the globe behind one DTV transmission standard (and its related production standard) immense advantages in international contribution feeds and intercontinental exchange of programs would be possible. Should this result from the early adoption of a United States based standard, it

is United States workers who will reap the economic benefits. This will happen only with a mandated standard. Without a mandate, it will take years to sort out the disparate DTV transmissions that will inevitably take hold in the United States market. The world will have moved on to adopt one of the many competing standards -- perhaps DVB from Europe or some variation of one proposed by the Japanese broadcaster NTV -- and the United States will have tragically lost a significant economic benefit for American industry.

We need only to look back to the history of AM stereo for confirmation. Even though a viable and desirable format, AM stereo was never accepted in the United States market to the extent that it has been in other countries because the Commission chose not to mandate a standard. In 1993, Congress directed a single standard, but by that time years of uncertainty and the difficulty of producing multi-standard receivers had reduced the confidence of both consumers and manufacturers.[2] We urge the Commission not to repeat this unfortunate example.

In addition, by encouraging a timely transition, a mandated standard will help ensure the earliest possible return of the analog spectrum -- one of the Commission's important goals. There is enough uncertainty surrounding the time it will take to transition from analog to digital without adding the uncertainty that would result from no clearly mandated digital ATV standard.

[2] For further details we refer the Commission to the comments of the Advanced Television Systems Committee in this proceeding.

IV. ALL TECHNICAL ELEMENTS OF THE PROPOSED STANDARD SHOULD BE INCLUDED IN THE MANDATE AS THEY REPRESENT PROVEN TECHNOLOGY AND WERE DESIGNED FOR FLEXIBILITY.

We believe that requiring use of some of the layers of the DTV transmission standard but not others would be not only contrary to the original mandate that launched this mammoth nine-year quest for a definitive ATV standard, but also seriously ill-advised. These closely related technical design layers were carefully crafted by ACATS to structure a robust, reliable and enduring standard. These layers working together, as they were meant to do by the consensus process, result in the superb digital performance demonstrated during ATTC lab and field tests and the recent over-the-air-test in Las Vegas at this year's NAB show. Digital transmission of high bit rates over a severely limited bandwidth and electronically hostile terrestrial channel can be reliably implemented only by the careful dovetailing of a minimum set of "layers."

The collaborative development program crafted by the many experienced contributors to the Grand Alliance (under the very close technical supervision of ACATS) would be irrevocably shattered if any one of the layers were allowed to assume new and totally independent design criteria. Indeed, while it is true that the original proponents had different solutions to the problems presented at each layer, once the Grand Alliance was formed a new system was created with the best parts of all proposed systems. From that point on the notion of independent layers ceased to exist. The system was designed to consist of multiple layers and will work only with all the pieces integrated. As we discuss below, omitting any from the mandate will seriously impede technical efficiency, format flexibility, transmission robustness, and interoperatility. It is all elements together

that give the necessary assurances and information to broadcasters which will encourage them to invest in new transmission equipment. Omitting any would result in uncertainty and retard the rapid transition to digital signal transmission. It would also result in the destruction of the Grand Alliance system and the promise of U.S. leadership in the worldwide digital transmission future.

V-chip and closed captioning -- two legislatively mandated capabilities of future television broadcasting -- depend on adoption of the standard in its entirety to provide a context for their development.[3]

In addition, as we explain below, the standard as designed provides the flexibility necessary to accommodate the interests of the computer and motion picture industries. SEL is deeply involved in most of the core technologies required to implement a digital HDTV system. We offer the following comments, not to endlessly repeat the technical discourse already dealt with, in great detail, within the ACATS process -- but rather, as an overview of those key points still apparently not understood by most of the critics of the ATSC DTV standard. We offer our comments from the perspective of a manufacturer who has made a major investment in time (almost 15 years) and resources grappling with the difficult technical challenges associated with digital HDTV and one who has equal interest in the future of television receivers, personal computers, and digital telecommunications.

[3] See filing of ATSC in this proceeding.

1. Interlace-Progressive Scanning:

There is a body of opinion within the computer industry, and some motion picture film practitioners, that retaining an interlace format. together with the preponderance of progressive scanning formats within the ATSC DTV standard, will somehow imperil future interoperability between television and computing media. It appears to be forgotten that the standard under review is a transmission standard, and as such, is quite different from a display signal format standard. Critics seem not to realize the crucial point that in an all-digital system the need for close technical coordination among initial program production, program transmission, and final program display standards is not as great as in analog. Progressive or interlace scanning can be deployed within any of these segments of the total television system -- and digital techniques are today readily available that allow appropriate conversions between them. This decoupling contributes significantly to the flexibility of the ATSC DTV standard. Simplistic doomsday conclusions, therefore, that a preliminary interlace transmission implementation will permanently obviate a future incorporation of a progressive "superset" have no technical basis whatever. The passion with which some in the computer industry (and some from the film production community) inveigh against ANY employment of interlace scanning in the ATSC DTV standard ignores two significant realities:

* All television systems in the world - with no exception - are today exclusively based upon interlace scanning.
* The best technical minds of the television industry are united in their pragmatic agreement to include an interlace mode within a number of progressive scanning

formats for the U.S. DTV standard.

Interlace works. In the context of normal television program material, it works remarkably well. Progressive scanning is technically better, in that it improves vertical resolution on the final display, and eliminates one of the aliasing components associated with the sub-sampled nature of television scanning. How much better the resultant picture really becomes is, however, a topic of fierce debate between the television and the computer engineer. For most television program content the improvements are subjectively quite small. On very fine detail text that might also be scrolling vertically, however, the improvement can be quite marked. Television program producers never employ fine detail text because it cannot be seen at normal television viewing distances which makes interlace more than sufficient. Moreover, progressive scanning does not come "for free." It is accompanied by one penalty that the computer industry is free to ignore but which is pivotal within a television system: namely, a doubling of bandwidth necessary to transmit the same spatial resolution and a 60 Hz frame rate in place of the 60 Hz field rate of interlace.[4] At every node of the complex television system, and within every equipment used throughout the entirety of that system, the television engineer is confronted by a significant number of imaging constraints that directly relate to bandwidth (and its associated digital data rate).

Interlace has become, therefore, one more powerful tool in the unceasing quest to properly manage bandwidth and, as a consequence, optimize all of the multiple

[4] "If Progressive Scanning is so Good, How Bad is Interlace?" By Laurence J. Thorpe and T. Hanabusa, SMPTE Journal, December 1990, Pages 972 -- 986.

dimensions of television image quality, while simultaneously minimizing an even larger array of picture impairments (of which, the interlace artifact is actually one minor element).[5] It is in the assignment of an appropriate "weighting factor" to the interlace artifacts where television and computer technical experts sharply diverge.

To illustrate this divergence, it is useful to consider the perspective of the television engineer on issues of progressive and interlace scanning within all three elements of the total television system: production, transmission, and display,

Production:

Today's HD telecines all employ progressive scanning in the conversion of the film image to HDTV video. This is true whether the scanning structure is full HDTV resolution (1920 x 1080) or the subset 1280 x 720 specified in the DTV standard. It is a relatively simple matter for these telecines to output the final processed component video signals as 24/30 fps progressive [or as 60 Hz interlace]. Regardless, the Grand Alliance DTV encoder has the means incorporated to perfectly deinterlace the 60 Hz interlaced output which allows full 1920x1080 resolution film transfers to be transmitted in 24/30 frame per second progressive.

The live HDTV television camera, on the other hand, is squarely confronted with the bandwidth limitation dilemma if it is to originate full 1920x1080 spatial resolution at 60 pictures per second. Bandwidth is directly related to signal to noise, which in turn is closely related to the camera operating sensitivity, the most important technical factor to a

[5] "HDTV Production -- The Technical Dilemma within the Progressive versus Interlace Debate" by Laurence J. Thorpe, Proceedings of HDTV World Conference 1993.

broadcaster (who must always render credible live pictures under all sorts of lighting conditions). Here, interlace scanning in the camera provides a double benefit to camera operational sensitivity: the technique used in CCD interlace readout immediately doubles the opto-electronic sensitivity of the sensor. and the attendant containment of bandwidth provides a 9 dB signal to noise advantage. This difference is clearly indicated in the published specification of a contemporary 1920x1035 60 Hz interlaced HDTV production camera and that of a new 1280 x 720 60 frame progressive camera shown at NAB '96:

	1920 x 1035 Interlace Camera	1280 x 720 Progressive Camera
Sensitivity:	F 8.0 @ 2000 Lux	F 4.0 @ 1200 Lux (Published)
Sensitivity:	F 8.0	F 5.0 (Comparative @ 2000 Lux)
Signal to Noise (30 Mhz)	54 dB	50 dB

No apologies are needed in the case of the progressive camera design and performance specifications. This camera is merely exhibiting both the sensitivity and signal to noise ratio shortcomings that are entirely predictable for progressive scanning given today's state of the art in HDTV's CCD imager technology, coupled with the fundamental bandwidth restriction earlier discussed. These shortcomings would worsen if the progressive camera had the higher 1920 x 1080 spatial resolution. It is absolutely inevitable that these shortcomings will ultimately yield to technological developments,

but this evolution must run its normal course. No amount of wishful thinking is going to short-circuit the substantial developments that will be required. It will be a decade, at least, before this can be achieved cost-effectively. In the meantime, broadcasters and program producers will quickly immediately benefit from the 1 1/2 F-Stop sensitivity advantage, and the signal to noise advantage of the interlace camera because they can make all the difference between capturing imagery at a major sports event (especially at night), or a special event such as the Pope's visit, or an opera or concert where lighting must be curtailed.

Transmission:

It is important that the Commission note that no party advocating the total removal of the interlace mode from the ATSC DTV standard has offered any technical comments whatever on how the high spatial resolution 60 Hz 1920 x 1080 HDTV signal is to be transmitted through the 6 MHz broadcast channel. In the context of today's BEST compression technology, it simply cannot be done other than in the interlace mode. Any summary dismissal of this intractable bandwidth reality suggests a puzzling confusion and lack of any genuine desire for a pragmatic compromise in the spirit of the open industry-based ACATS process.

Two of the most important and demanding types of programming that must be transmitted by HDTV are motion picture films and live sporting events. Despite the disparate technical requirements of these programs, the genius of the Grand Alliance

system is that it can accommodate them both and allow for their transmission at the highest level of HDTV performance from the beginning of a U.S. DTV service.

Some in the Hollywood creative community have recently observed that their works must be transmitted in a progressive format to fully preserve their artistic integrity. This point was clearly recognized by the developers of the Grand Alliance system, since so much of US television prime-time programming (and most high-end television commercials) will continue to be originated on very high resolution 35mm motion picture film. The result is that, contrary to the fears expressed by some cinematographers, the system will allow for the transmission of programs originated in film at 24 and 30 fps at full 1920 x 1080 spatial resolution using progressive scan, from the moment the DTV system goes on line.

At the same time, marketplace experience has demonstrated the significance of live news and sporting events as a key factor in the rapid acceptance of both current and emerging television systems.[6] The Grand Alliance system also accommodates this reality by allowing for the transmission of such events at 60 Hz in full 1920 x 1080 spatial resolution using interlace scan, within the limitations of today's compression technology and a 6 Hhz broadcast channel.

Electronic noise has been the nemesis of the television engineer since the dawn of electronic imaging. It manifests itself as a primary picture impairment right in the television camera, or telecine, that originates the video signal. Noise also appears as a

[6] SEL's experience with our new DSS (Digital Satellite System) product supports the assertion. The vast majority of our customers are interested in this new product for the variety of sports programming it offers, along with the excellence of the picture provided by digital transmission and reception.

particularly challenging disturbance in television signal transmission -- every consumer is quite familiar with the snow that can grossly contaminate the weaker received television signal.

In digital television transmission, noise can be a particularly insidious intruder. Electronic noise in the source video signal itself is the mortal enemy of the digital compression algorithm (becoming more so as the compression ratio becomes greater). In video compression systems the resultant digital bit-stream is substantially reduced compared to the data volume of the original digital video signal. Each compressed picture element then has a higher burden in the reconstruction of the video picture because of the large amount of digital image information that has to be derived from closely compressed data. Hence, it can be said that an efficient compression system is that one that best uses its available digital capacity in the compression of "image-related information."

When noise accompanies a video signal, even the most sophisticated compression techniques fail to "recognize" what is video and what is noise. As a result, precious compressed data is used to try to "compress" the noise portion of the signal and to prevent valuable "bit resources" from being used on the actual video signal.

What is more visually annoying, is that with the compression system now being at the point of running out of bits for the compression of the video related features, the presence of visually complex motion or even some static scenes will make the system break down with severe visual compression artifacts. Therefore it is critical for picture sources that are to be bit-reduced be as free as possible of noise signals in order to obtain

the best picture quality of the compression process under the constraints of a data-rate limited storage or transmission channel.

What is not commonly understood outside of the television program production community, is how volatile the noise generation mechanism can be within the video origination process (that is, the television camera or telecine). An HDTV or an SDTV camera, shooting a ball game in the evening as natural light is waning requires a continuous intervention on the part of the video production supervisor (who must increase camera video gain and adjust lens aperture to balance the needs of maintaining signal levels and optical depth of field while also being cognizant of the attendant increase in noise). In analog television the program producer can intuitively assess the noise level in terms of how it will ultimately translate into the living room picture (a familarity with the average level of television transmission noise helps put a perspective on these "creative " decisions).

In DTV transmission such intuition is irrevocably lost . The picture noise content that is increased by needed television camera adjustments will trigger digital transmission compression artifacts. The program producer has no way of anticipating such problems. Comfortable operating margins in camera (or telecine) signal to noise ratio thus become crucially important in this DTV system environment.

The margin of safety in digital television transmission through a 6MHz RF channel is small. Of necessity, the compression ratios involved are very high, and the compression algorithm has very little reserve to deal effectively with source picture contaminents such as noise -- and particularly noise levels that are under no specific

control. Within the context of the protracted progressive-interlace technical debate within ATSC in 1992, this digital transmission vulnerability was initially pointed out by by J.Kumada (a scientist at the NHK Technical Research Labs) in his seminal paper submitted to the ATSC.[7] It was clearly shown in this paper that interlace scanning , with its inherent 9dB camera source signal to noise advantage over progressive scanning (for the same spatial resolution and picture capture rate), would add an important safety margin to protect digital transmitted signal integrity

This source signal noise dilemma can reach extremes in broadcast news gathering, where urgent resort to very high video gains (with a consequent dramatic decrease in camera signal to noise ratio) are made on a quite regular basis -- when shooting scenes in very low available light (dim unlit interiors), or at night. Thus, within the confines of today's compression technology, interlace scanning is a benign expedient that offers one more important degree of freedom in managing intelligent compromises in overall picture quality versus picture impairments.

Display:

Most of the problems relating to interlace artifacts manifest themselves in the final picture displayed on the video screen. Fortunately, almost all of the artifacts can be eliminated or ameliorated by a scan upconversion that takes the 60 Hz interlace signal up to full 60 frame progressive display. Some will perpetuate the debate on the quality of

[7] "Consideration on Progressive Camera from the Viewpoint of Signal-to-Noise Ratio" by Jun Kamada (NHK Tech Research Lab), ATSC Document: ATSC T4 TF - 0006/Oct. 92, ATSC/T4 Task Force on HDTV Production Standard